CHAPTER TWO
CROPPING PATTERN AND CROP DIVERSIFICATION: CONCEPTUAL ISSUES AND EMPIRICAL DEBATES

2.1 The theoretical and empirical literature available on cropping pattern and crop diversification deals with a number of dimensions. The present review of this literature has been organized under the following five subheads, each dealing with one specific issue such as concepts and definitions of cropping pattern and crop diversification; determinants of cropping pattern and crop diversification; crop diversification as a strategy to cope with risks; benefits and hazards of crop diversification; and crop diversification in the contemporary economic environment.

2.2 Cropping Pattern and Crop Diversification: The Concepts and Definitions
Cropping pattern means the proportion of total cropped area under different crops at a point of time in a particular geographical area. The cropping pattern in a particular region is subject to changes depending on a large number of factors like climate, rainfall, agricultural technology, availability of irrigation facilities, relative price and profitability of various crops, and so on. A change in the cropping pattern in a particular geographical area implies a change in the proportion of area under different crops within the area concerned. Such changes may lead to either concentration around a few crops or diversification of crops depending on the nature of such changes.

However, the idea of crop diversification has not been precise and clear cut as that of cropping pattern. Gunasena (2006), Yahya (2006), Raju (2005) and Doane (1944) have attempted to define crop diversification after classifying it into
two broad categories — horizontal diversification and vertical diversification. Horizontal diversification refers to the cultivation of an increasing number of crops on a plot as against one or two major crops. According to Gunasena (2006), the main form and commonly understood concept of crop diversification is the addition of more crops to the existing cropping systems. This type of crop diversification means broadening the base of the system, simply by adding more and more crops. On the other hand, vertical diversification refers to the upstream and downstream activities of a particular crop or crops (Yahya, 2006). It is a long process, which starts from primary production of raw materials, goes through primary and secondary processing and finally the finished products. This vertical form of diversification emphasizes on intra and inter-sector linkages thereby developing the relevant value chain.

In the words of Mengxiao (2006), crop diversification firstly refers to the species diversification of cultivated crops and secondly to the diversification of varieties and ecotypes of the same variety to maximize outputs of primary products as well as value added processed products.

Luat (2006) has broadly defined crop diversification as the strategy of shifting from less profitable to more profitable crops, changing of variety and cropping system, increasing exports and competitiveness in both domestic and international market, protecting the environment and making conditions favourable for combining agriculture-fishery-forestry-livestock. Thus this definition focuses on the diversification of agricultural activities beyond crop cultivation to include the other forms of farming. Joshi et al (2002) held that within the agricultural sector, diversification is a shift from one crop to another crop or from one enterprise to another in terms of area, production, income, uses and transfer of resources.
De (2003) has defined crop diversification as a structural change in crop-mix in a geographical area. In terms of input use, it means a change in the use of basic agricultural inputs from one combination of crops to another. He held that crop diversification may take place either by a change in acreage distribution per crop or a change in value-wise contribution of each crop to total agricultural production.

According to Joshi et al (2005), crop diversification is considered as a shift of resources from one crop to a larger mix of crops, keeping in view the varying nature of risks and expected returns from each crop and adjusting it in such a way that it leads to optimum portfolio of income.

Délgado and Siamwalla (1997) are of the view that the prime objective of the process of crop diversification is to generate a portfolio of income from activities with different degrees of risk, expected returns, liquidity and seasonality, and adjust their output mix accordingly. In practice this process involves allocation of household productive assets among different income generating activities.

In India crop diversification is generally viewed as a shift from traditionally grown less remunerative crops to more remunerative crops (Hazra, 2004). In a similar line Raju (2005) has defined diversification as a shift from food to commercial crops and to non-food crops, from unremunerative crops to horticulture and aquaculture and within horticulture from long gestation fruits to short duration crops and vegetables. Likewise, Pingali and Rosegrant (1995) describe diversification of agriculture in general and crop diversification in particular as a change in product choice and input use decision based on market forces and the principle of profit maximization.
The term 'crop diversification' is often used to imply a shift from food crops to cash crops or to crops meant for sale in the market. However, according to Grimes (1929) crop diversification may also take place in terms of producing a wider variety of commodities like cereals, fruits, vegetables etc. for household consumption rather than for commercial purposes. Diversification of this type does not result in increase in cash income but provides income in kind which is often considered to be more important than its equivalent in cash income from the point of view of a better balanced diet.

In view of the above discussion the term 'crop diversification' in the context of the present study has been used in the sense of reallocation of resources to accommodate a more diverse cropping pattern. The inducement for such a process may arise from optimization of twin goals of maximization of farm income and mitigation of risks associated with the farming practices. Moreover, crop diversification in the present study has been measured on the basis of area as well as value shares of individual crops in total crop portfolio.

2.3 Determinants of Cropping Pattern and Crop Diversification

The cropping pattern and crop diversification in a particular geographical area depends on different categories of factors. All the factors may not be equally important under all circumstances and times. The World Bank (1990) has put forward a detailed list of factors under the broad categories of agronomic, economic and policy factors in this regard as determinants of crop diversification strategies as mentioned in Table 2.1.

According to Hazra (2004), the cropping pattern changes over time is the result of the interactive effect of several factors, which he has categorized into following five groups:- (i) Resource related factors (covering irrigation, rainfall and soil
fertility), (ii) Technology related factors (covering not only seed, fertilizer and water technologies but also those related to marketing, storage and processing), (iii) Household related factors (covering food and fodder self sufficiency requirement as well as investment capacity), (iv) Price related factors (covering output and input prices as well as trade policies and other economic policies that affect these prices either directly or indirectly), (v) Institutional and infrastructure related factors (covering farm size and tenancy arrangements, research, extension and marketing systems and government regulatory policies). All these factors are interrelated and their relative importance changes over time.

Table 2.1: Agronomic, Economic and Policy Factors for Diversification

<table>
<thead>
<tr>
<th>Agronomic/Technical</th>
<th>Economic</th>
<th>Government Policy</th>
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<tbody>
<tr>
<td>★Climate and soil type (irrigation, topography, fertility, drainage etc.)</td>
<td>★Means for risk management</td>
<td>★Non-distortionary policy that discriminate among crops</td>
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<tr>
<td>★Availability of required inputs (fertilizer, chemical, credit, tractors etc.)</td>
<td>★Flow of market signals and communication and information systems</td>
<td>★Broad based demand driven efficient research and extension programmes, without any bias for major crops or against high value crops.</td>
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<tr>
<td>★Plant/seed of high genetic quality</td>
<td>★Means for vertical diversification</td>
<td>★Contract-farming opportunities</td>
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<tr>
<td>★Management techniques and quality managers</td>
<td>★Venture capital and entrepreneurship</td>
<td>★Available market strategies to reduce production and marketing risk and costs</td>
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<td>★Appropriate scale and organizational form (inc. no monopolies)</td>
<td>★Transparency of input and output prices</td>
<td>★Rural credit and markets for other inputs</td>
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<tr>
<td>★Abundance of labour of appropriate mechanical technologies</td>
<td>★Information on export standards, market demand and relative profitability</td>
<td>★Off-farm employment opportunities</td>
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<td></td>
<td>★Efficient marketing systems</td>
<td>★Marketing systems (including satisfying quality standards)</td>
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<td></td>
<td></td>
<td>★Involvement of the private sector</td>
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The agronomic conditions, which cannot be changed and remain constant over a period of time, greatly limit the scope for crop diversification. Given these, other factors can interact to affect and alter the cropping pattern and crop diversification. However, the limiting impact of such agronomic conditions on the diversification opportunities can sometimes be neutralized to some extent through introduction of appropriate technologies (Vyas, 1996).

For example, development of rice varieties with shorter growing season could make it possible for farmers to grow rice in areas with restricted water supply in the critical growing period. Similarly, attractive price and profitability of some crops relative to that of other crops may induce modification and innovation of technical implements needed to remove the conditions hostile to the production of those crops (De, 2003).

The most significant technological change, which has remarkably impacted upon the cropping pattern changes, is irrigation. Irrigation has a very significant role to play in diversification of crops. Singhal and Gauraha (1997), while studying crop diversification in Madhya Pradesh found that the factors responsible for crop diversification were mainly rainfall and irrigation. Likewise, Birthal et al (2006) found that irrigation mainly through tubewells or pumpsets has a positive and significant impact on the level of diversification. In a similar line, Pant (1992) in a study in one of the areas of Lucknow found that irrigation had a great role in changing the cropping pattern. He is of the view that the tremendous change in the cropping pattern in the said area from bajra to paddy and from gram to wheat is on account of greater availability of water. Likewise Singh et al (1997) in a study of regional variations in agricultural performance in India found that irrigation has substantial impact on acreage growth of different crops in West
Bengal and other states. These findings are consistent with the findings by Gupta and Tewari (1985). This is, however, in sharp contrast to the findings by Rao et al. (2004) and Saieth (1997). According to Rao et al. (2004), irrigated areas are specializing towards rice and wheat whereas the rain-fed areas are diversifying into fruits and vegetables as they require less water for their cultivation. Better irrigation seems to impose a kind of forced specialization centered on water intensive crops like paddy, sugarcane etc (Saieth, 1997).

There are several studies (Gupta and Tewari, 1985; Anosike and Coughenour, 1990; Pope and Prescott, 1980) dealing with the relationship of crop (and agricultural) diversification and various socioeconomic variables like farm size, family size, net wealth, education and experience of the farmers, organizational form of the farm, nature of land ownership etc.

The effect of size of the farm on diversification of crops has been reported in several empirical writings with quite contrasting findings. In a study in California, Pope and Prescott (1980) found that larger farms are more diversified. They argued that this may be due to the absence of sufficient economies of scale in any commodity to warrant specialization for the large farms. A similar type of positive relationship between farm size and diversification was observed by some other studies (Anosike and Coughenour, 1990; Coughenour, 1980; Gasson, 1988; Ilbery, 1991). Culas (2003) in a study of Norway also found the same type of relationship that large farms are more diversified but he put forward a different explanation. According to him, regional specialization in agriculture was politically desirable in Norway, which is thought to be responsible for the current ‘excess production’ and increasing pollution. But the recent agricultural policy of the country emphasizes on environmental friendly production system, sometimes with government support of subsidies. This may be the reason, as held by Culas.
of the large farms being more diversified as farm diversification is regarded as one of the measures of environmental friendly agricultural production (Ellis, 1993). This is in sharp contrast to the findings of some other studies (White and Irwin, 1972; Gupta and Tewari, 1985; Mishra, et al, 2004), which show an inverse relationship between farm size and level of crop diversification. Another study on the Allahabad district of Uttar Pradesh also revealed that crop diversification is inversely related to farm size (Gupta and Tewari, 1985). This may be due to the fact that one might expect the larger farms to be more specialized when there are scale economies in an enterprise. Another possible explanation for the inverse between farm size and diversification as held by Mishra et al (2004) is that since farm size and wealth tend to be positively correlated, one can deduce that wealthier farms are less risk averse and hence less diversified, other things being equal.

As far as the economic conditions of the farmers are concerned it is found that the wealthier farms are relatively less diversified (Pope and Prescott, 1980; Gupta and Tewari, 1985). These results are consistent with risk theories. That means, the farms diversify to spread risk and wealthier farms are less risk averse and hence, less diversified.

Pope and Prescott (1980) found that younger and less experienced farmers are more specialized. This might be due to the fact that young farmers are less risk averse and it may be difficult for the less experienced farmers to manage diverse activities. However, Mishra et al. (2004) found that older farm operators are less likely to diversify. They argue that older farm operators have more wealth, wealthy farms are less risk averse and hence less diversified. On the other hand, young and beginner farm operators are more risk averse and in the wealth accumulation phase of their life cycle. However, they acknowledged the
possibility that young farmers may start small and diversified, and perhaps become more specialized as they expand their operation. This argument is quite contrary to that of Pope and Prescott (1980) when they say that more plausibly young farmers may start small and specialized and perhaps become more diversified as they expand their operation. But Anosike and Coughenour (1990) refute any such significant relationship between experience of the farmers and the level of diversification and found a very strong positive relationship between farmers' level of education (human capital) and diversification. They argued that diversification as a risk management strategy requires human capital for an effective management in farming.

According to Anosike and Coughenour (1990), the form of farm organization does not impact farmers' diversification decisions. On the contrary, Pope and Prescott (1980) in a study in California found that corporate farms are more specialized than other farms.

The cropping pattern and crop diversification is also largely influenced by the market-related factors, especially relative costs and prices of crops. Vyas (1996) considered market as the most important factor determining the pattern of crop diversification. Among the market forces he has emphasized more on prices. To him the significant changes as has been observed in the last few years in the cropping pattern of India are mainly due to changes in the relative prices. In this context he has cited the example of oilseeds. The growth of oilseeds both in the kharif and rabi seasons in several parts of the country is at the cost of less profitable crops in those regions. The decline in the profitability of traditional crops and an increase of the same in case of non-traditional high value crops, especially in the 1990s has been reported by Barghouti et al (2004) as the most important economic factor influencing crop diversification. Vyas (1996) has,
besides prices, given due importance to market infrastructure such as transport and communication facilities, marketing network and institutional arrangements like delivery system of inputs and credit as other important market forces determining cropping pattern. Likewise, Narain (1965) observed that the shifts in cropping pattern are due to changes in the relative prices of crops, expansion of irrigation and changes in technology, all of which alter the relative profitability of crops. While analyzing supply response to price, he has distinguished between the production for self-consumption and production for market. He made the conclusion that rainfall, broadly weather, plays a leading role in determining area under self-consumption of food grain production whereas prices are the major determinants of area under commercial crops.

According to Joshi et al (2005), there are several forces, which influence the nature and speed of agricultural diversification from staple food to high value commodities. They have classified these forces broadly into demand and supply side forces. The demand side forces include per capita income and urbanization. The supply side forces include infrastructure (market and roads) and technology (relative profitability and risk in different commodities), apart from resource endowments (water and labour) and socio-economic variables (pressure on land and literacy rate).

While referring to different categories of factors influencing the cropping pattern choice and crop diversification Hazra (2004) has given more emphasis on economic factors. According to him, irrigation expansion, infrastructure development, penetration of rural markets, development and spread of short duration and drought resistant crop technologies have all contributed to minimizing the role of non-economic factors in crop choice of even small farmers. Moreover, the reform initiative undertaken in the context of ongoing agricultural
liberalization and globalization policies are also going to further strengthen the role of price related economic incentives in determining crop composition both at the macro and micro levels. In a condition where agricultural growth results more from productivity improvements than from area expansion, which has happened in many parts of India, price related economic incentives can pave the way for the next stage of agricultural revolution where growth originates more and more from value added production.

As against the general observation Kar et al (2003) found that the development of infrastructures such as road, irrigation facility and literacy among the rural people negatively influence crop diversification. They argue that the speed of transformation from subsistence to commercialization depends upon linkages between two-way channel of demand and supply of crucial farm inputs and outputs. Indian agriculture is in a stage where there is not sufficient surplus food grain production to be disposed off in the market. Further they found that with the improvements in rural literacy farmers shifted area from pulses, oilseeds, coarse cereals to superior cereals due to profit motive and to reduce risk. However, they found that consumption of fertilizer and village electrification have positive and significant impact on crop diversification.

The crop choice or nature of crop diversification also depends on the stage of production. In the early stage or traditionally backward society, the farmers, specially small and marginal farmers usually allot a major portion of their cultivable land for the production of means of self consumption. The risk averse subsistence farmers are likely to adopt a technology of food production that combines a low mean yield with low variance relative to alternative technologies and crops promising a higher mean yield but with greater variance (Todaro and Smith, 2003). However, in case of such subsistence farming diversification within
the food crops is possible as a strategy against production uncertainty. But with
the establishment of market linkage diversification takes place away from
subsistence to commercial crops. However, as this process of commercialization
gets momentum there can be further shift towards commercial crops, especially
high value crops thereby leading to specialization in these crops. In the capitalist
farming system it is possible even for the small farmers to collect the means of
subsistence from the market in exchange of money that had earlier been
obtained in exchange of goods produced by the individual farmers.

The government policies have also a very important role in influencing the nature
of cropping pattern and extent of crop diversification (Vyas, 1996; Hazra, 2004).
Mahesh (1999) found that state intervention played an important role in the
cropping pattern changes in the state of Kerala. For example, the abolition of
food zones and distribution of rice at subsidized prices through price shops led to
a decline in the open market price of rice, which was an important factor
responsible for making the rice cultivation unremunerative thereby leading to a
continued decline in the area under rice over the years. On the other hand, he
found that in case of rubber the development support given by Rubber Board
through financial and technical assistance and the existence of assured market
for rubber provided incentives for cultivators to bring new areas under it. On the
other hand, in India greater emphasis was put by the policy makers on food
security in the mid-sixties. As a result the whole series of policy interventions like
price policy, credit policy, research and development policy etc. were designed to
favour production of food grains. Even today when the country has achieved
considerable self-sufficiency in food grain production the public policies still
favour rice and wheat production in terms of minimum support price (MSP) and
subsidies. Such bias puts several handicaps in diversifying agricultural
production through a shift from wheat and rice to other crops (Vyas, 1996). Realizing the importance of government interventions in this regard Gupta and Sharma (2006) have suggested in a study on Himachal Pradesh that the government should undertake necessary steps to overcome the infrastructural bottlenecks like marketing, storage and processing to make crop diversification possible. According to Bathla (2006), the globalization policy of the Government of India by opening up agriculture to world trade along with streamlining of trading rules under the Uruguay Round of Agreement of Agriculture (AoA) of the WTO is further expected to provide incentives for changes in area in favour of those commodities that have greater demand at the global level and are also price competitive.

2.4 Crop Diversification as a Strategy to Cope with Risk

Theoretical Considerations:

People face different types of risks and uncertainties in their day to day activities of economic life. Agriculture sector is no exception to this. Farmers face uncertainties and risks from various sources, There-are basically two types of risks in this regard, viz., production risk arising out of disease, pests, weather condition, rainfall, flood, drought etc. and price risk resulting from fluctuations in the market.

A farm operator who is faced with uncertainty regarding price or yield outcomes may wish to select an enterprise mix which minimizes the variability of total returns from it. Most of the literature dealing with minimization of risk of a portfolio has widely used the mean-variance (E-V) approach. The decision rule used by a farmer to choose the appropriate enterprise mix from a large number of

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1 Here, the terms 'risk' and 'uncertainty' have been used interchangeably. The term 'risk' has been used more in 'Neumann-Morgenstern' sense rather than that of Knight
possibilities (if not unlimited possibilities, as feasibility of crop combinations to be pursued by a farmer is severely limited by agro-economic conditions) is to maximize utility of returns to be derived from the possible enterprise portfolio. The utility depends positively on mean and negatively on variance of returns. Thus, the utility function can be specified as

\[ U = U(E, V) \]

Where, \( \frac{\partial U}{\partial E} > 0 \) and \( \frac{\partial U}{\partial V} < 0 \) ---- (1.1)

For the ease of estimation the utility function can be taken in linear form as shown below

\[ U(E, V) = E - bV \] ---- (1.2)

Where, \( b \) represents the subjective risk coefficient of the farm operator. A farmer will choose that portfolio of enterprises which maximizes his utility. For sake of simplicity if the farm operator undertakes two enterprises, then the utility function can be given as

\[ U(Z) = \lambda \mu_x + (1 - \lambda) \mu_y - b[\lambda^2 \sigma_x^2 + \sigma_y^2 + 2 \rho \lambda (1 - \lambda) \sigma_x \sigma_y] \] \[ U(Z) = \lambda \mu_x + (1 - \lambda) \mu_y - b[\lambda^2 \sigma_x^2 + \sigma_y^2 + 2 \lambda (1 - \lambda) \text{Cov}(X, Y)] \] ---- (1.3)

Where, \( Z \) represents returns from the portfolio of two enterprises \( X \) and \( Y \). \( \lambda \geq 0 \) is the fraction of total portfolio allocated to enterprise \( X \);

\( (1 - \lambda) \geq 0 \) is the fraction of total portfolio allocated to enterprise \( Y \);

\( \mu_x \) and \( \mu_y \) are the mean or expected returns from enterprise \( X \) and \( Y \) respectively.

Thus the expected value of returns\(^2\) from the portfolio is

\[ E(Z) = \lambda \mu_x + (1 - \lambda) \mu_y \] ---- (1.4)

\(^2\) An operator will choose two enterprises \( X \) and \( Y \), if \( E(X, Y) > E(X) \) and \( E(X, Y) > E(Y) \). That is, if expected returns from combining two enterprises are more than the expected returns from individual enterprises.

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And variance of returns from the portfolio is

\[ \sigma^2 = \lambda^2 \sigma_X^2 + (1 - \lambda)^2 \sigma_Y^2 + 2\rho \lambda (1 - \lambda) \sigma_X \sigma_Y \]

\[ \sigma^2 = \lambda^2 \sigma_X^2 + (1 - \lambda)^2 \sigma_Y^2 + 2\lambda (1 - \lambda) \text{Cov}(X,Y) \]  \hspace{1cm} (1.5)

Where, \( \rho \sigma_X \sigma_Y \) is covariance between the enterprises \( X \) and \( Y \); \( \rho \) is correlation coefficient\(^3\) between them.

Now, the optimization problem of the farm operator can be looked into two ways, i.e., maximization of mean and minimization of variance of returns as shown by equation (1.4) and (1.5) respectively. This is because of the fact that minimization of variance of income in the short run is a means to maximization of returns in the long run (Heady, 1952).

Thus the first order condition for maximization of utility \( U \) is

\[ \frac{dU}{d\lambda} = \mu_X - \mu_X - \frac{b[2\lambda \sigma_X^2 + 2(1 - \lambda) \sigma_Y^2 + (2 - 4\lambda) \text{Cov}(X,Y)]}{2Xa^2} = 0 \]  \hspace{1cm} (1.6)

Similarly, the first order condition for minimization of variance of returns is—

\[ \frac{d\sigma^2}{d\lambda} = 2\lambda \sigma_X^2 - 2(1 - \lambda) \sigma_Y^2 + (2 - 4\lambda) \text{Cov}(X, Y) = 0 \]  \hspace{1cm} (1.7)

Now, solving for \( \lambda \) gives

\[ \lambda = \frac{\sigma_Y^2 - \text{Cov}(X, Y)}{\sigma_X^2 + \sigma_Y^2 - 2\text{Cov}(X, Y)} \]  \hspace{1cm} (1.8)

The above model may be generalized for more than two enterprises. Let us assume that the returns from the \( i^{th} \) enterprise are \( R_i \) and the proportion of the portfolio allocated to enterprise \( i \) is \( \lambda_i \).

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\(^3\) If returns from the two enterprises are perfectly correlated, i.e., \( \rho = 1 \), variance will be higher than a situation when \( \rho < 1 \)
Then total returns from the portfolio is given by

\[ TR = \sum_{i=1}^{n} \lambda_i R_i \]  

(1.9)

Mean and variance of total returns are

\[ E(TR) = \sum_{i=1}^{n} \lambda_i E(R_i) \]  

(1.10)

\[ Var(TR) = \sum_{i=1}^{n} \lambda_i^2 Var(R_i) + 2 \sum_{i=1}^{n} \sum_{j=1}^{n} \lambda_i \lambda_j Cov(R_i, R_j) \text{ for } i \neq j \]  

(1.11)

Although the model outlined above looks elegant it tries to show optimization of twin objectives of maximization of returns and minimization of its variance separately. However, it is unrealistic to assume that farmers optimize these objectives separately and independently. A more realistic approach would be to assume that the farmer optimizes an objective function where expected income enters with a positive coefficient and risk factor with a negative coefficient. In that sense the model would be akin to the one used for explaining portfolio diversification while balancing between expected returns and its variance in financial investment. In the present context, thus, crop diversification can be seen as a strategy adopted by the farmers to strike a balance between expected income and uncertainty of returns associated with crop cultivation.

**Empirical Evidence:**

Different studies have provided considerable amount of evidence that people are generally risk averse in their attitude towards risk (Meyer, 2003). Diversification of farm enterprises is a widely held risk reduction strategy followed by the farmers (Anosike and Coughenour, 1990; Mishra et al, 2004). According to Valdivia (1996), diversification smooths the flow of income of the households by reducing both predictable and unpredictable fluctuations. Barghouti et al. (2004)
held that one of the most common rationales for diversification of output mix is to reduce environmental (climatic shocks), ecological (pest and disease) and economic risk associated with uncertainty and variations of net income.

Indian agriculture is characterized by risk and uncertainty as more than two-third of the cultivable land is dependent on monsoon (Gopalappa, 1996). The farmers are often the victims of natural and market induced risk. Crop diversification is suggested as an important strategy to cope with risk and uncertainty associated with agriculture due to climatic and biological vagaries (Shiyani and Pandya, 1998; Kumar et al, 2002). Gupta and Tewari (1985), in a study in Allahabad found that the farmers who perceive greater risk resorts to diversification of crops more as a means of risk aversion. Blade and Slinkard (2002) identified risk reduction as one of the factors promoting diversification of crops. According to them, the inclusion of several species in a crop production plan can have the advantage of buffering low prices in a specific crop and that diversification allows a producer to balance low prices in one or two crops with reasonable prices in other commodities. In another study on Kerala Mahesh (1999) observed that in order to spread risk arising out of fluctuations in the prices of agricultural products the farmers diversified their crops preferring those that are expected to give a steady income. They were found to prefer coconut cultivation because of its greater reliability in the long run and that it can be inter-cropped with banana, tubers, pepper etc. Such pattern of cropping was found to provide a reasonable level of income from land and at the same time minimize risk due to crop failures and price fluctuations.

A choice of correct combinations of crops or cropping pattern can be used as a useful tool to minimize the possible devastations and damages from drought and flood like situations. In a study on the drought hit state of Rajasthan Rathore
(2004) has depicted how a correct crop mix and cropping pattern has been adopted by the farmers as one of the few strategies to cope with risk of drought. The farmers were growing those crops which are highly drought resistant. The farmers of the areas with scarcity of water put a larger area under mustard because of its less water intensity. They adopted a mixed cropping system which allowed them to follow a flexible production schedule in terms of their responses to varying rainfall patterns. For example, the farmers in the Western part shifted from millet to other crops such as sesame and water melon when early rains appeared to be inadequate or when rains were concentrated in the latter part of the wet season. Adoption of quick maturing seed varieties was also on the rise due to the recurrence of drought. Moreover, a large number of crops and their combinations were used to take care of climatic risk.

The crop growing sector in Assam is faced with great risk and uncertainty due to frequent floods causing an extensive damage every year, which is an important source of instability in agricultural production in the state (Mandal 2010; 2011). According to Mandal (2010), in the flood plains of Assam an attempt by the farmers to minimize this production risk due to frequent flood has led many of them to adjust the cropping pattern and/or season. Over a period of time and especially since the deployment of STWs based irrigation system in the late 1990s, many farmers in the state have adopted a risk mitigation strategy as a result of which there has been a decline in the acreage share of kharif food grains and an increase in that of rabi food grains and vegetables. In another study Purkayastha (2005) has shown how in the Nagaon district of Assam the farmers largely settled in geographically disadvantaged areas (char areas) are trying hard to cope with the recurrent and prolonged floods and experiment with
different crop combinations, often successfully in low-lying fields or heavily silted land.

2.5 Benefits and Hazards of Crop Diversification

The traditional cropping pattern characterized by mono cropping or emphasis on one or two crop varieties has led to serious economic, social and ecological problems such as deceleration in productivity growth, drop in agricultural employment, overexploitation of ground water resources and decline in soil fertility in many areas. According to Sidhu and Dhillon (1997), in Punjab soil has deteriorated because of excessive use of chemical fertilizers and growing the same crops over and over again. The over dependence of Punjab on rice and wheat has led to some serious ecological and production related marketing problems (Sidhu and Sidhu, 1988). According to Kar et al (2003), in the states of Punjab, Haryana and Uttar Pradesh continuation of rice-wheat system led to much negative externalities such as decline in ground water table, pollution of ground water through fertilizer and pesticides and deceleration in soil health.

Diversification of cropping pattern may help the farmers to use their resources more efficiently and at the same time promote sustainability of agricultural production (Anosike and Coughneour, 1990). Goetz (1997) held that the farsighted behaviour of the farmers regarding maximization of long run net returns in the presence of renewable resource essential for production as well as sustainable agricultural production requires diversification of crops. Diversification of crops through the use of rotations suited to the site-specific conditions at the local level has been demonstrated to be beneficial in protecting soil quality and productivity over the long term and can contribute to higher and more stable net income (Zentner et al, 2002). According to Wu et al (1995), one way to reduce the potential for water pollution in agriculture is to change the crop
mix since different crops require different types and amounts of chemicals and hence, they differ in their potential to generate water pollution. Kutcher et al (2005) add in this regard that diversification of crops and cropping systems is expected to result in a more environmentally and economically sustainable farming system. It is to be noted that a crop growing system characterized by a diverse crops and crop groups reduces the requirements of the inputs like pesticides and fertilizers which have dangerous implications for precious resources like water and land.

According to Goletti (1999), diversification offers an opportunity to arrest environmental degradation through an economically sound multi-commodity production system. Crop rotations based on legumes, intercropping, and relay cropping help to reduce the need for nitrogen fertilizer whose manufacture requires a considerable amount of non-renewable fossil fuel energy.

While referring to the advantages to the deployment of crop diversification Guy et al (2004) held that intercropping can reduce invasion of pest and the number to which they can grow, protect the soil from erosion and evaporation and improve quality of the product.

Crop diversification can also have beneficial impacts upon employment generation. Diversification of crops, especially to high value crops may prove to be instrumental in enhancing employment opportunities because of the fact that these crops are highly labour intensive. In a study von Braun (1995) demonstrated that as a result of diversification into vegetable production in Guatemala (Central America), employment increased by 45 per cent. In another study Ali and Abedullah (2002) showed that substantial employment opportunities are generated through diversification out of cereals to high-value commodities like vegetables via employment in various activities such as seed
and seedling production, precision land preparation, irrigation, harvesting, cleaning, grading and packaging of the high value crops. They estimated that a one-hectare shift of cereal to vegetables in one season generates more than one year-round full-time employment. The man-hour requirement per hectare of high value crops (fruits and vegetables) are almost 2-3 times higher compared to the traditional crops (Joshi et al, 2004). Due to high degree of seasonality in agriculture, an important motive behind diversification could be to provide for more productive year-round employment of household resources (Valdivia et al., 1996). The high-value crops as compared to cereals are more strongly interlinked with other sectors of the economy (Barghouti et al, 2004) and hence, can provide great impetus to additional employment and income generation through forward and backward linkages. According to Chadha and Gulati (2002), farm level diversification will generate substantial employment effects from the industrial expansion and value-adding opportunities opened through greater availability of marketable raw agricultural products. Table 2.2 illustrates the employment effects of crop diversification in some selected countries as reported by Ali and Abedullah (2002).

**Table 2.2 Average Labour use in Vegetables and Cereals (person days/ha) in Some Selected Countries**

<table>
<thead>
<tr>
<th>Crop Group</th>
<th>Cambodia</th>
<th>Laos</th>
<th>North Vietnam</th>
<th>South Vietnam</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
<td>81</td>
<td>101</td>
<td>216</td>
<td>111</td>
<td>127</td>
</tr>
<tr>
<td>Overall vegetables</td>
<td>437</td>
<td>227</td>
<td>468</td>
<td>297</td>
<td>357</td>
</tr>
<tr>
<td>Tubers</td>
<td>79</td>
<td>-</td>
<td>294</td>
<td>303</td>
<td>225</td>
</tr>
<tr>
<td>Allium (onions, garlic)</td>
<td>542</td>
<td>191</td>
<td>454</td>
<td>317</td>
<td>376</td>
</tr>
<tr>
<td>Cucurbits (cucumbers etc.)</td>
<td>373</td>
<td>309</td>
<td>533</td>
<td>264</td>
<td>370</td>
</tr>
<tr>
<td>Leafy vegetables</td>
<td>502</td>
<td>207</td>
<td>517</td>
<td>253</td>
<td>370</td>
</tr>
</tbody>
</table>

*Source: Ali and Abedullah (2002)*
Dutta et al (2005) held the view that there are certain advantages to adoption of crop diversification which include stability of yields, reduced risk of crop failure, increased productivity, increased agro-returns, enhanced employment, conservation and enhancement of natural resources and so on.

Several other economists have also discussed the benefits of crop diversification which include, among other things, shifting consumption pattern into a wider range of commodities, generating employment opportunities, alleviating poverty, improving productivity of scarce resources, promoting exports, improving environmentally sustainable farming systems through conservation and enhancement of natural resources (Jha, 1996; Ramesh Chand, 1996; Vyas, 1996; Joshi et al, 2005).

**Role of Diversification in Rural Development:**

Diversification of crops has also an important role in the overall development of the rural areas. Changes in existing cropping pattern over time within the crop-growing sector are considered as one of the basic characteristics of a progressive agricultural economy (De, 2003). According to Pingali (2004), commercialization and diversification of agricultural system is a universal phenomenon of a growing economy. As the economy grows, there is a gradual movement from a subsistence food crop production, generally in a monoculture system, to a diversified market oriented production.

According to Todaro and Smith (2003), in an economy with the vast majority of the people living in the rural areas, if development is to take place and become self-sustaining, it should start in the rural areas in general and the agricultural sector in particular. According to them, the core problems of widespread poverty, growing inequality, rapid population growth and rising unemployment — all are
mainly because of the stagnation and often retrogression of economic life in the rural areas. The same logic applies to Assam where around 70 per cent of the population lives in the rural areas and 53 per cent of total work force is engaged in agriculture (Census, 2001). Crop diversification can be used as an instrument for poverty alleviation (Kar et al, 2003). Moreover, Shiyani and Pandya (1998) held that crop diversification has been largely considered as a ray hope for the economic uplift of the small and marginal farmers.

The Staff Appraisal Report to ARIASP (World Bank, 2004) recognized that enhancement of agricultural productivity leading to growth in rural income and reduction of poverty, would require, among other things, intensification and diversification of crops. Another study by FAO and World Bank (FAO and WB, 2001) on farming systems and poverty has suggested that diversification is the single most important source of poverty reduction for small farmers in South and Southeast Asia.

**Adverse Impact of Crop Diversification:**

As evident from the above analysis there are a number of advantages of diversification of agriculture sector in general and crop growing sector in particular. However, according to Grimes (1929), the extent of the advantages is conditioned by the number of farmers attempting to secure them. If a considerably large number of farmers make similar changes, the price advantage of the particular product would quickly disappear as a result of an increased supply of that product. But this argument may not be valid in all circumstances because the extent of diversification or the farmers' choice to go for diversification depends not only on price but also on other factors like topography and soil content, irrigation, access to market, socio-economic characteristics of the farmers etc. Different regions and farmers are endowed with these resources
and factors differently and therefore, may not be equally successful in the same diversification strategy as a result of which the problem of excessive production may not arise at the macro level. Moreover, even if some surplus production emerges in a particular region that can be disposed off through a well-developed and efficient marketing network.

On the other hand, there are apprehensions that crop diversification prompted by commercial considerations may endanger food and nutrition security by way of a shift of area from food grains (Satyasai and Viswanathan, 1996). However, it needs to be mentioned that production of food grains has increased manifolds after the advent of green revolution on the one hand and there has been distinct shifts in the consumption patterns away from cereals to no-cereals on the other. According to Satyasai and Viswanathan (1996), while increase in food grain production has positively influenced food security, increase in consumption of non-food grains such as oilseeds, fruits and vegetables is an indication of improvement in the quality of food in terms of calorie and nutritional contents.

2.6 Crop Diversification in the Contemporary Economic Environment

According to Economic survey, Government of India (2002), large accumulation of rice and wheat stocks, along with a distinct shift in the consumption pattern away from cereals to non-cereals such as oilseeds, pulses, vegetables, fruits etc. is a stark reminder that the policy focus needs to be re-oriented towards diversifying agricultural production to meet the emerging market needs. With the passage of time greater concern for nutrition is likely to raise the demand for commodities like pulses, oilseeds, fruits and vegetables at a much faster pace while the demand for starchy staples is likely to creep up much more slowly (Vyas, 2003). Similarly, the process of economic growth accompanied by urbanization and globalization has led to a significant shift in the consumption
pattern in the Asian countries away from cereals towards high-value agricultural products such as vegetables, fruits, oils, fats and livestock products (Pingali, 2004).

According to Goletti (1999) a more globalised trade system offers new opportunities but at the same time presents several challenges. The ongoing economic reforms characterized by globalization have posed new challenges to the agricultural sector of developing countries and India in particular. Although there are apprehensions that opening up of the agriculture sector will adversely affect the developing countries through influx of subsidized cheap imports from the developed countries, some economists are optimistic that India can gain from the process through diversification of agriculture in favour of more competitive and high value quality products through an appropriate strategy to overcome many emerging challenges (Dileep et al., 2002; Joshi et al, 2005). In a study on agricultural diversification in South Asia, Joshi et al (2004) observes that there is evidence that the South Asian countries are able to raise their agricultural exports, especially of high value and labour-intensive commodities.

2.7 Summing Up
Cropping pattern refers to the proportion of area under different crops at a point of time in a particular geographical area. Crop diversification can be defined as a change in the area under different crops and a shift from one combination containing a few to another consisting of a larger number of crops. There are a number of factors which determine the cropping pattern and diversification of crops in a geographical area. They are mainly geographical factors like climate and soil conditions, technological factors like irrigation facilities, development of seeds, fertilizers etc., economic factors like relative prices of commodities, size of
holdings, urbanization, market infrastructure etc., policies of the government and so on.

There are several advantages to adoption of crop diversification. They include growth of agricultural production and productivity, stability of yields, reduced risk of crop failure, enhancement of employment, increased agro-returns, conservation and enhancement of natural resources etc. Crop diversification has also an important role in rural development.

Moreover, the potential challenges from opening up the agriculture sector in this era of globalization can be overcome to a great extent through diversification of agriculture in favour of more competitive and better quality products. Apart from these, crop diversification can be adopted as a strategy to cope with the uncertainties faced by the farmers in agricultural production and its prices.